

# Beaches as an Alternative to Riprap and Walls for Eroding Shorelines

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2021 Sierra Club  
SLR Symposium

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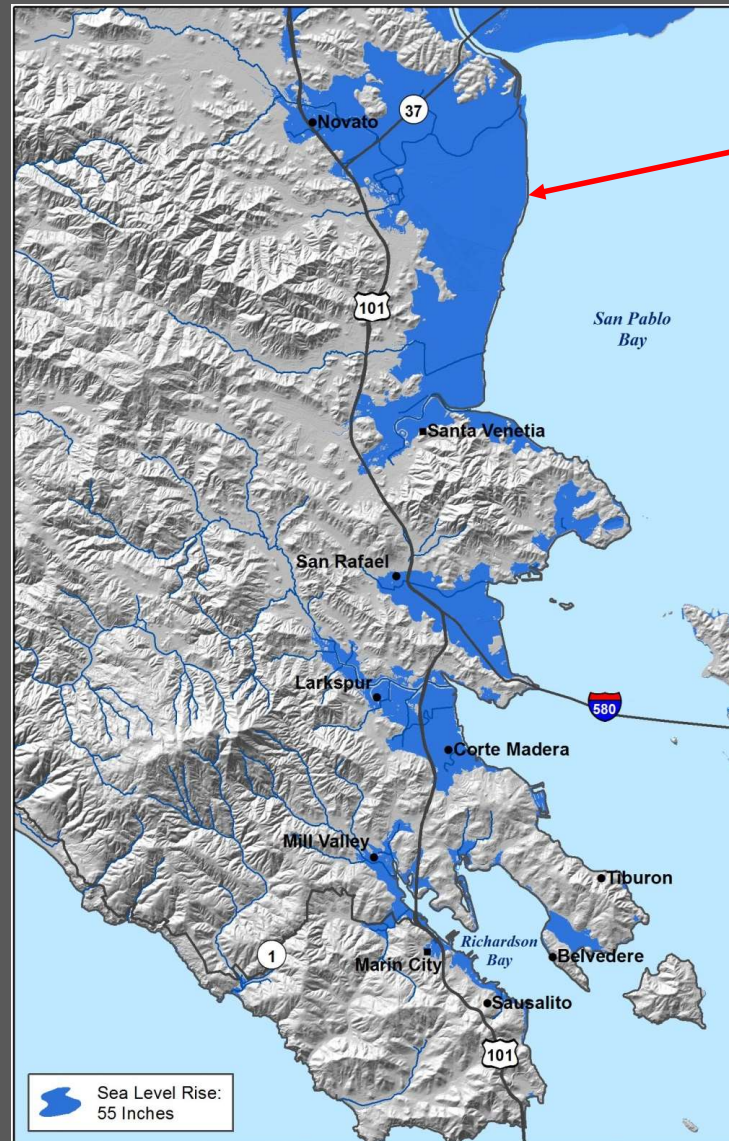
Point Isabel, Richmond



Marina Bay tombolo, Richmond

# Marin County

- low elevation along eastern edge
- Steep watersheds = flash flooding with downstream tidal boundary condition
- Highest # roads at risk per capita



*Existing shoreline*



# Sea Level Rise is More Than Flooding

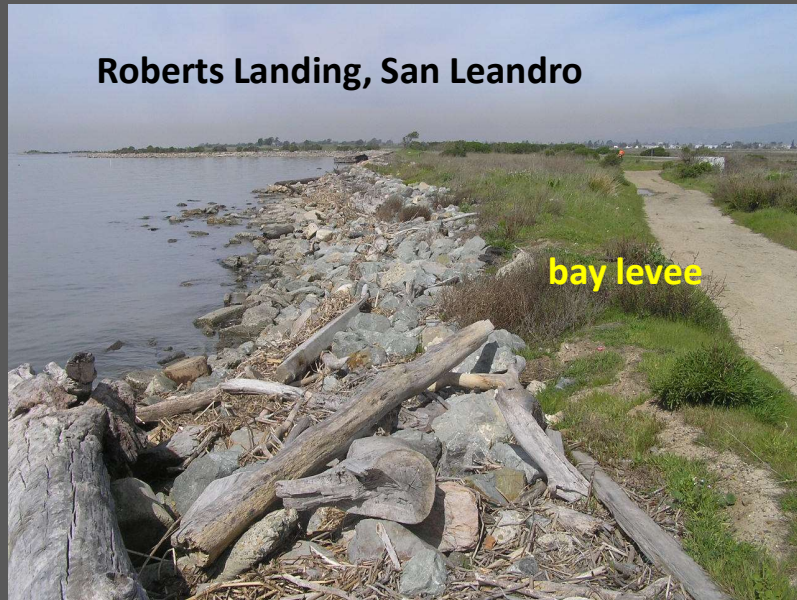
## Increased 21<sup>st</sup> c Wave Erosion at SF Bay Shorelines

- As sea level rises → deeper bay (deep water fetch↑, wave energy ↑)
- potential increase in urban route ferry traffic (wakes)



# Typical Bay Levee Rip-Rap Armoring (rip-rap, rubble, boulder revetments)

Roberts Landing, San Leandro



bay levee

Bel Marin Keys, Novato



bay levee armor

Powell St Emeryville



Peninsula fill (slag, rubble)



# Failing Hard Armoring of the Shoreline



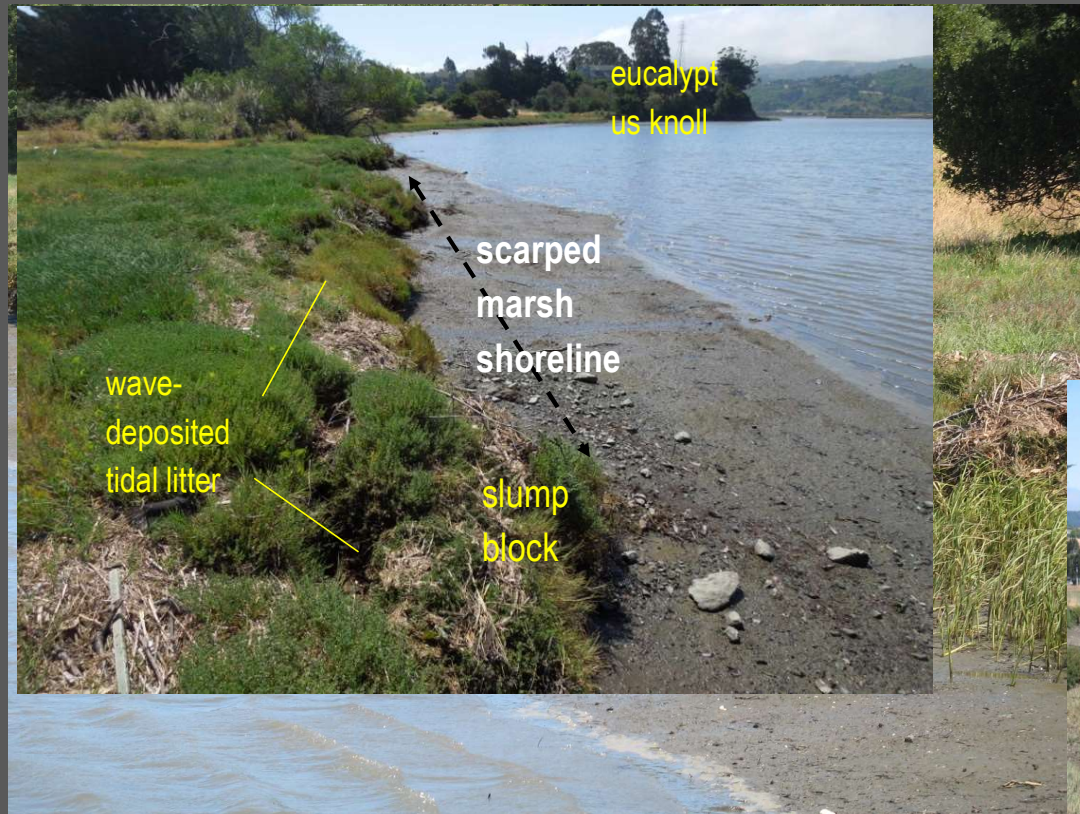
Wave erosion of fill *behind* concrete blocks



Paradise Beach, Marin County



# Loss of Tidal Marsh



*Mill Valley Shoreline*





# The shoreline future? rock and walls



*San Rafael shoreline*



## walls and rocks



*San Quentin shoreline*



# 2019 SFEI SLR Adaptation Atlas

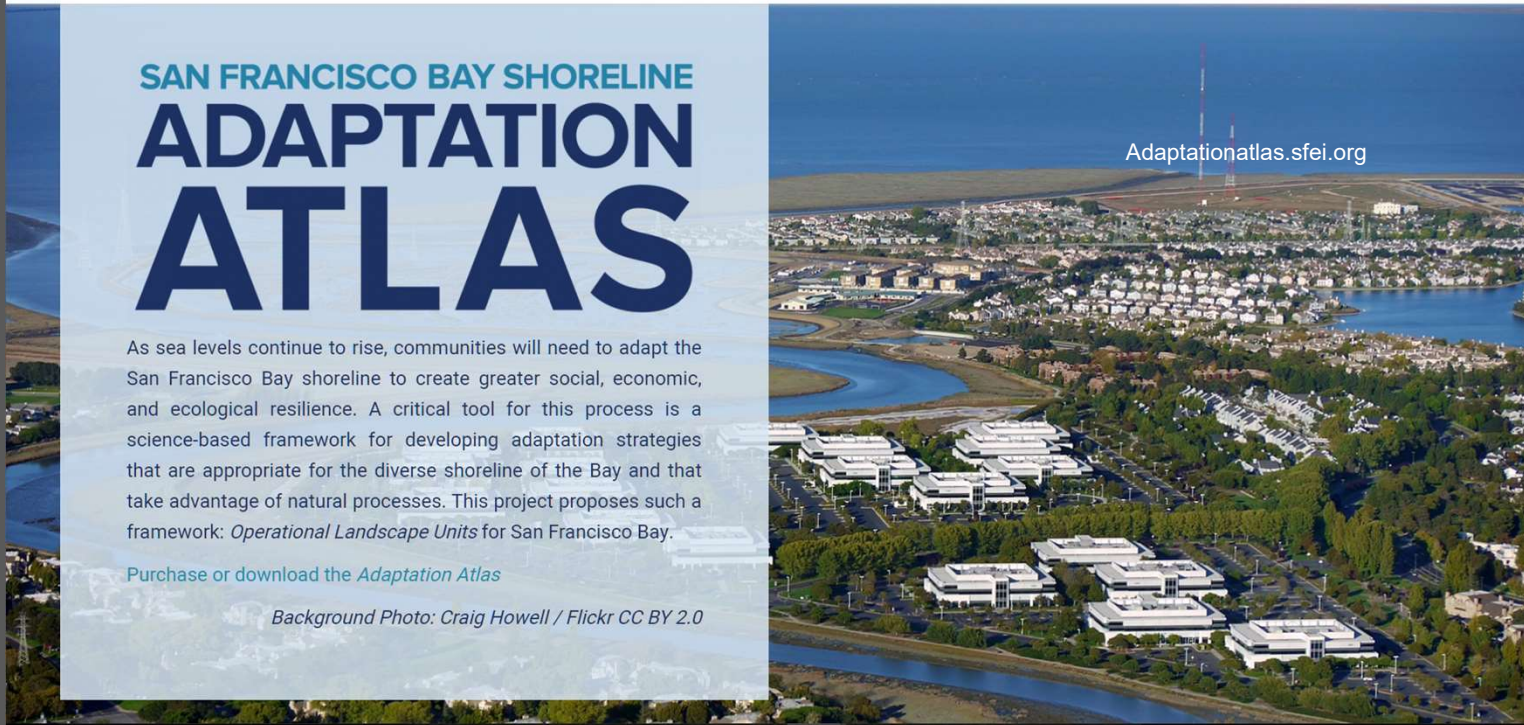
## SAN FRANCISCO BAY SHORELINE ADAPTATION ATLAS

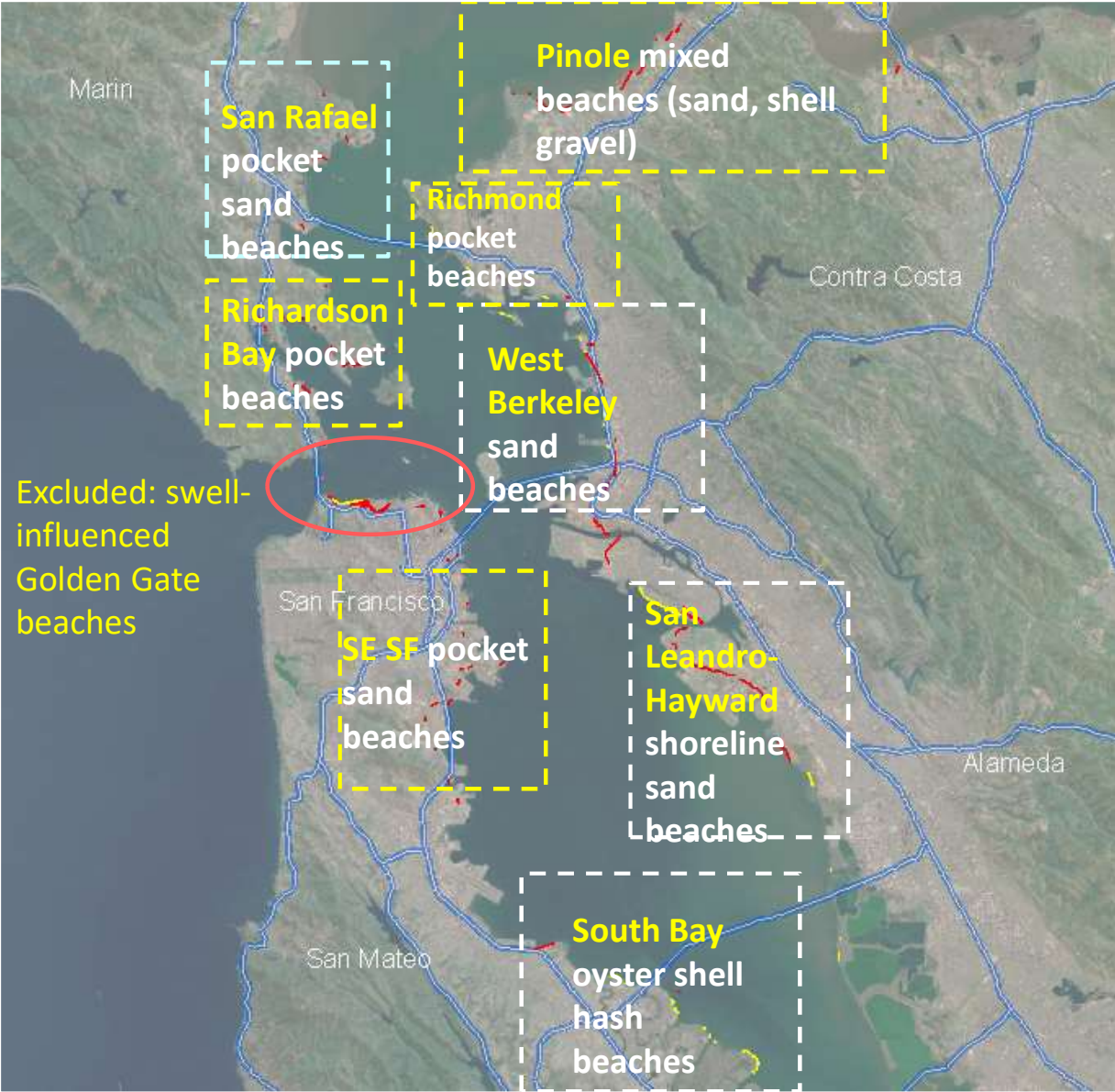
As sea levels continue to rise, communities will need to adapt the San Francisco Bay shoreline to create greater social, economic, and ecological resilience. A critical tool for this process is a science-based framework for developing adaptation strategies that are appropriate for the diverse shoreline of the Bay and that take advantage of natural processes. This project proposes such a framework: *Operational Landscape Units* for San Francisco Bay.

[Purchase or download the \*Adaptation Atlas\*](#)

*Background Photo: Craig Howell / Flickr CC BY 2.0*

[Adaptationatlas.sfei.org](http://Adaptationatlas.sfei.org)





## SF Bay beach provinces

- prevalent sediment type (sand, shell, gravel, mixed)
- geomorphic setting (headland, marsh fringe)

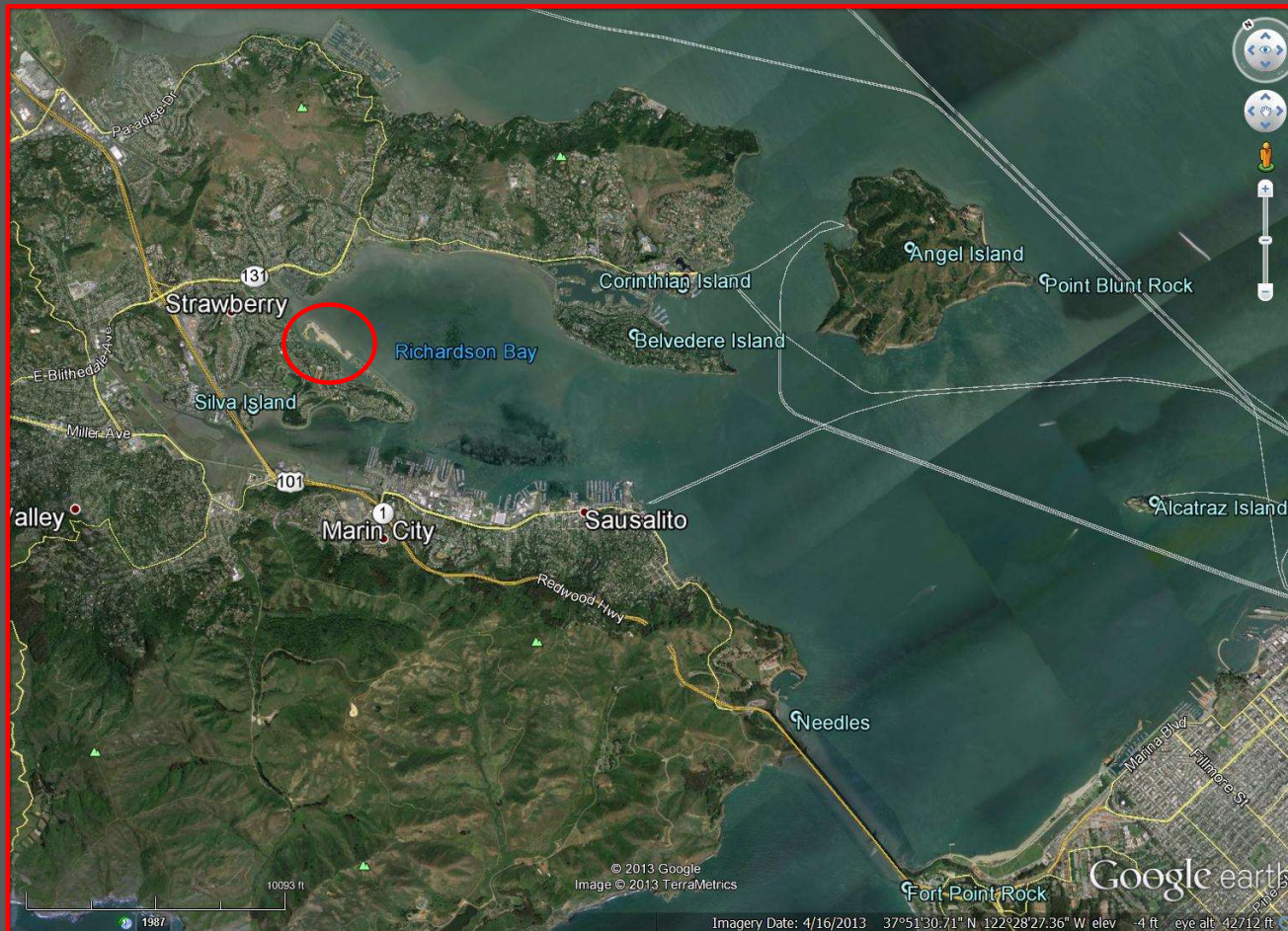
Base map credit: Mike Perlmutter, BAEDN

**Beach shorelines**

- historic
- modern



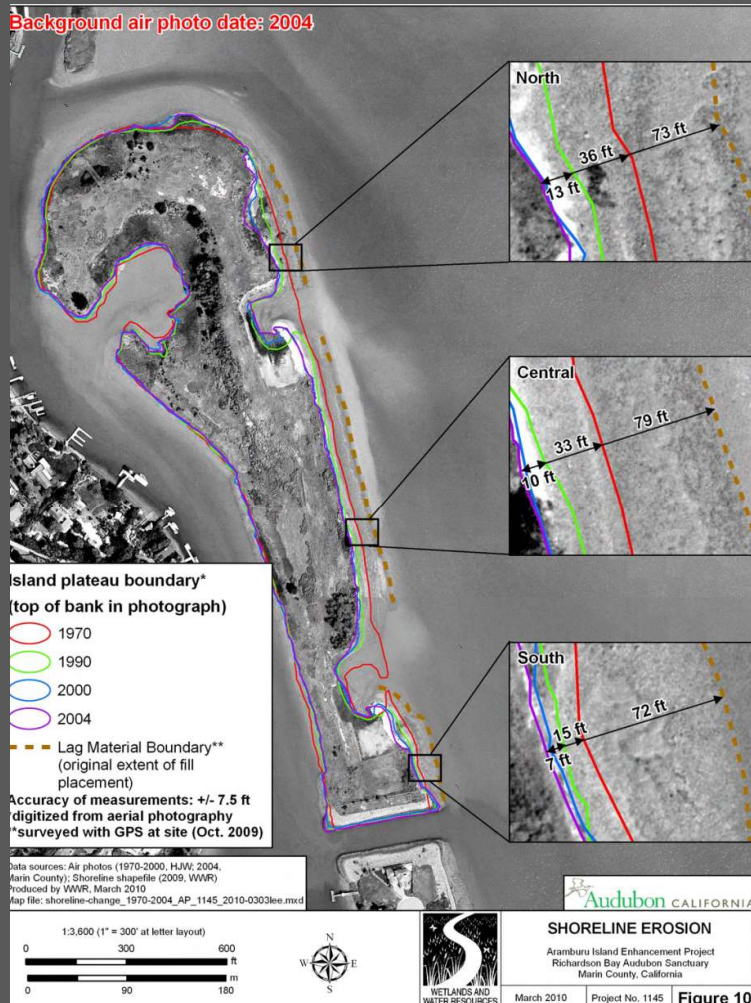
# Aramburu Island Engineered Beach Demonstration Project – Built 2011/2012





# Aramburu Island, Richardson Bay

## 45+ yr shoreline retreat > 130 ft; boulder-cobble lag



0.5-1.0 m wave erosion scarp





# 2007 Cosco Busan Oil Spill





# Aramburu Wave Climate



Wind-Wave  
Climate

Fetch = 8 miles  
southern storms

Significant wave  
height = 2-3 feet

Wave period = 2-  
3 seconds



## Degraded Island Features



# Shoreline Design

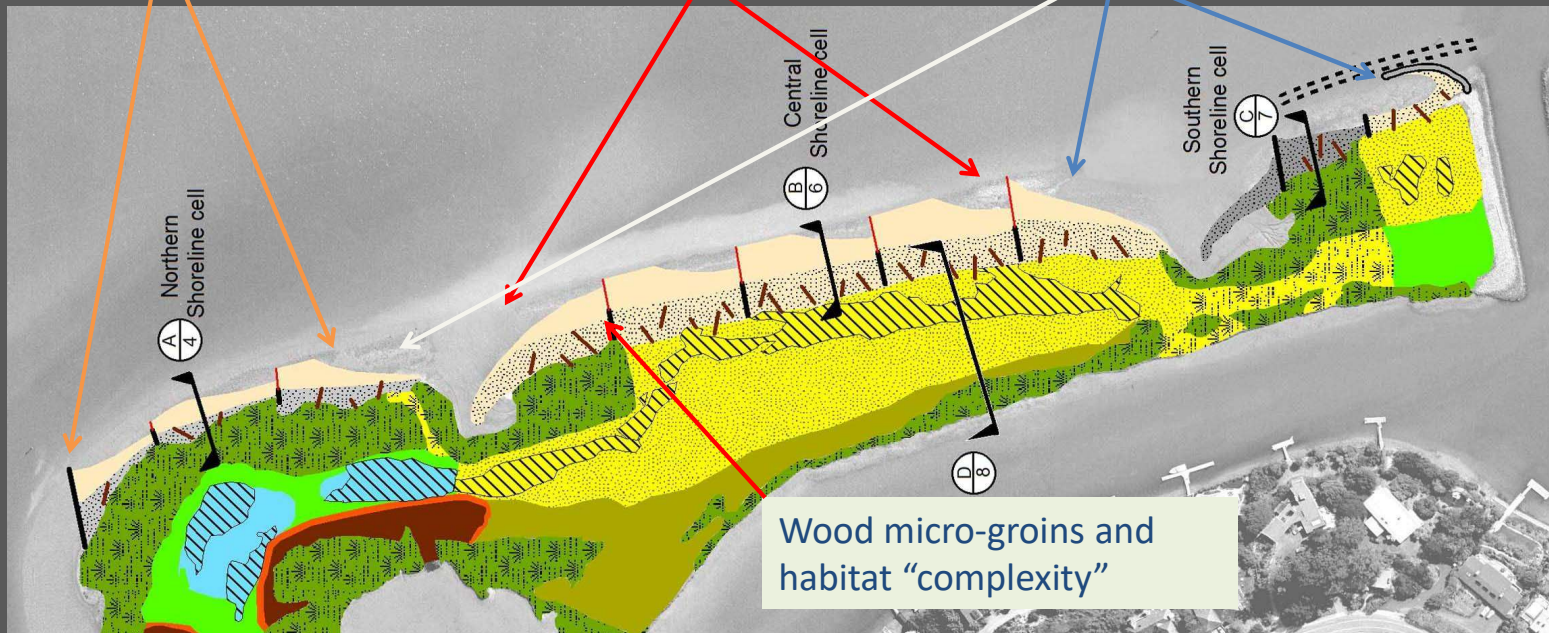
Lowest wave energy

Highest wave energy

Oyster shell at north end

Mixed gravels and oyster shell – central cell

Coarser sediments at south facing slopes





# San Francisco Bay natural coarse sediments vary with local sources and shoreline setting

- headland, stream mouths, nearshore erosion sources
- local wave climate (fetch, offshore water depth gradient)

MEDIUM SAND



GRAVEL

SHELL HASH



On to construction...



Grading back vertical wave-cut scarp; creating ramp-like platform for gradual beach retreat with rising sea level



## Initial Placement of Oyster Shell Hash, Prior to Wave-Reworking





Placement of oyster shell hash at N end, lowest wave energy gradient



# Placing larger wood groins – eucalyptus logs





## Sandy Foreshore Construction 2012



# Monitoring Photos 2012-2013



Dec 5, 2012 post construction  
Apr 16, 2013 post significant  
southern storms

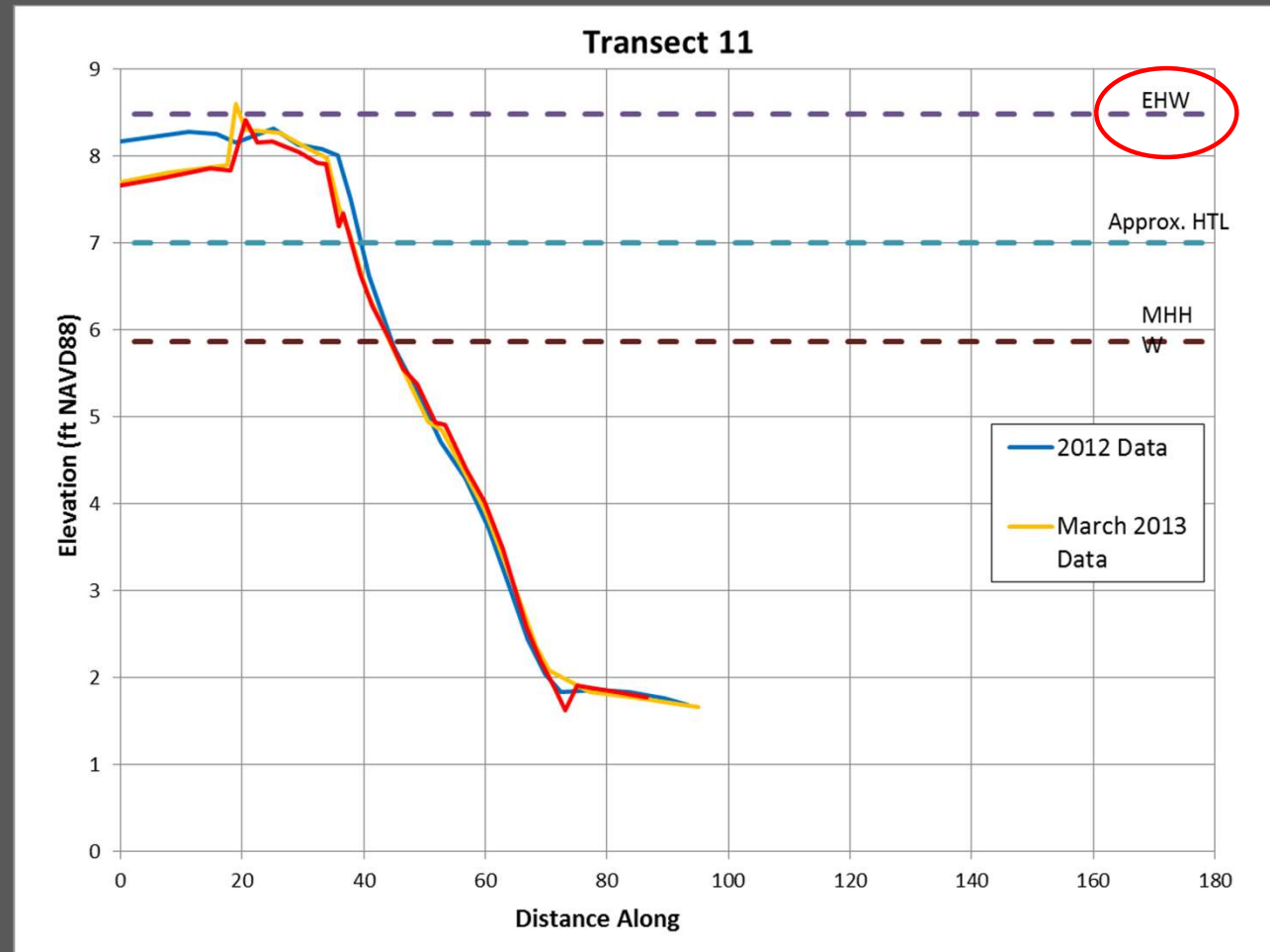


## Beach Profile Changes

High-energy, wave-exposed  
**HEADLAND**  
**gravel-cobble**  
**beach**

Stable beachface –  
cobble lag with  
interstitial fines

Beach crest  
elevation: mobile  
coarse sediment  
accretion to EHW





**Richardson Bay Audubon Center & Sanctuary** shared a link via Audubon California.

July 22 · Edited

We are so delighted to share this news! Black Oystercatchers are nesting on the newly-created shoreline of Aramburu Island. This is only the 4th known nesting site for this species within SF Bay, and the site of our habitat restoration project.



**Black Oystercatcher nest observed in Richardson Bay | California**

[ca.audubon.org](http://ca.audubon.org)

The nest illustrates the success of the newly constructed shoreline habitat of Aramburu Island, a location...

Like · Comment · Share

2 Shares



# PHOTOS: Black oystercatchers return to Aramburu Island in Richardson Bay

Posted Jul 30, 2014

By



You and 2 others recommend this. 2 people recommend this. Be the first of your friends.

Black oystercatchers and their chicks have appeared on Aramburu Island near Tiburon, a sign that restoration efforts on the small site are working. [Read the story](#)



2011: George Russell cartoon about remodel of Aramburu Island.

# Marin Bay Beaches Design Sites (MCF/SCC grant 2018)

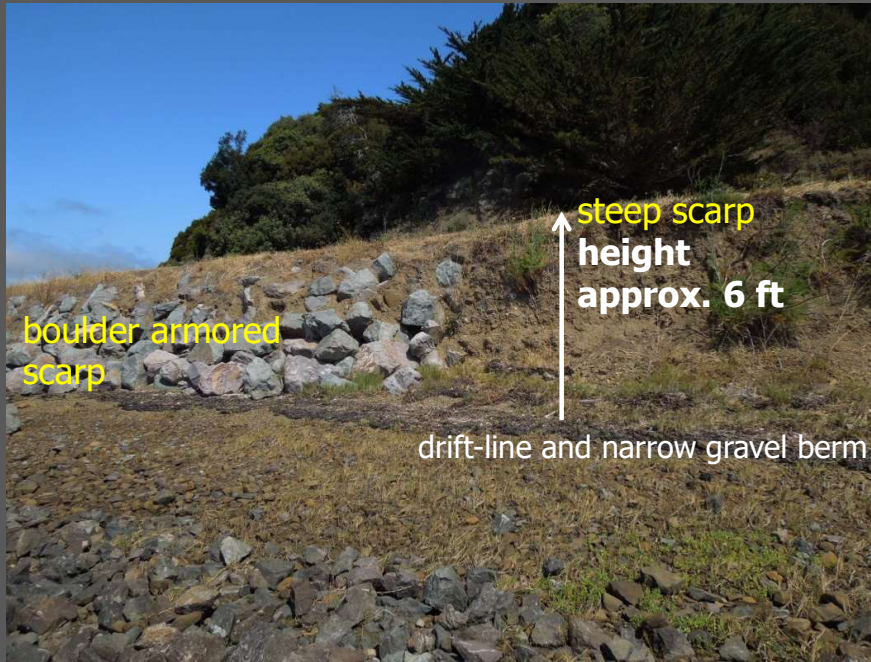








# Seminary Drive (protect roadway)





# Greenwood Beach, Tiburon, CA



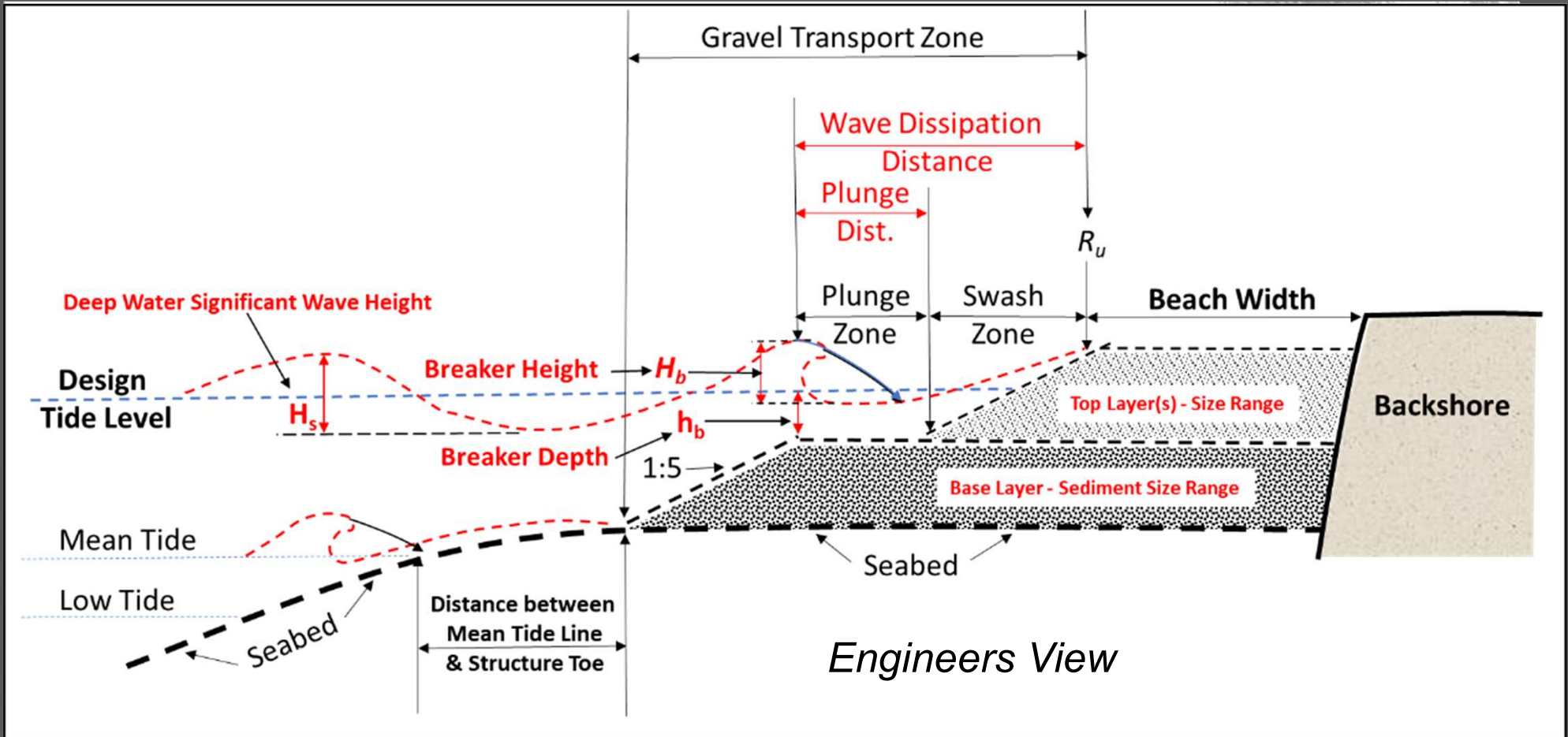


**Erosion of old bay fill exposes asphalt and concrete debris, rock**  
West shore (2019)





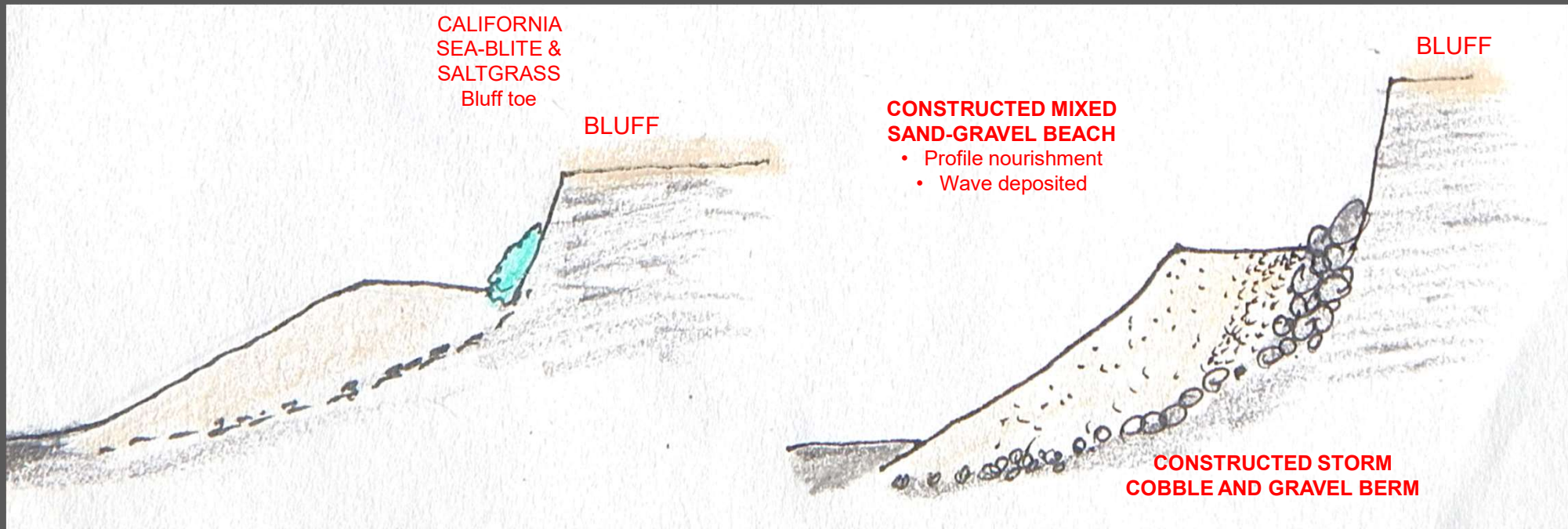
# Approach 1 - Engineered Gravel Beach



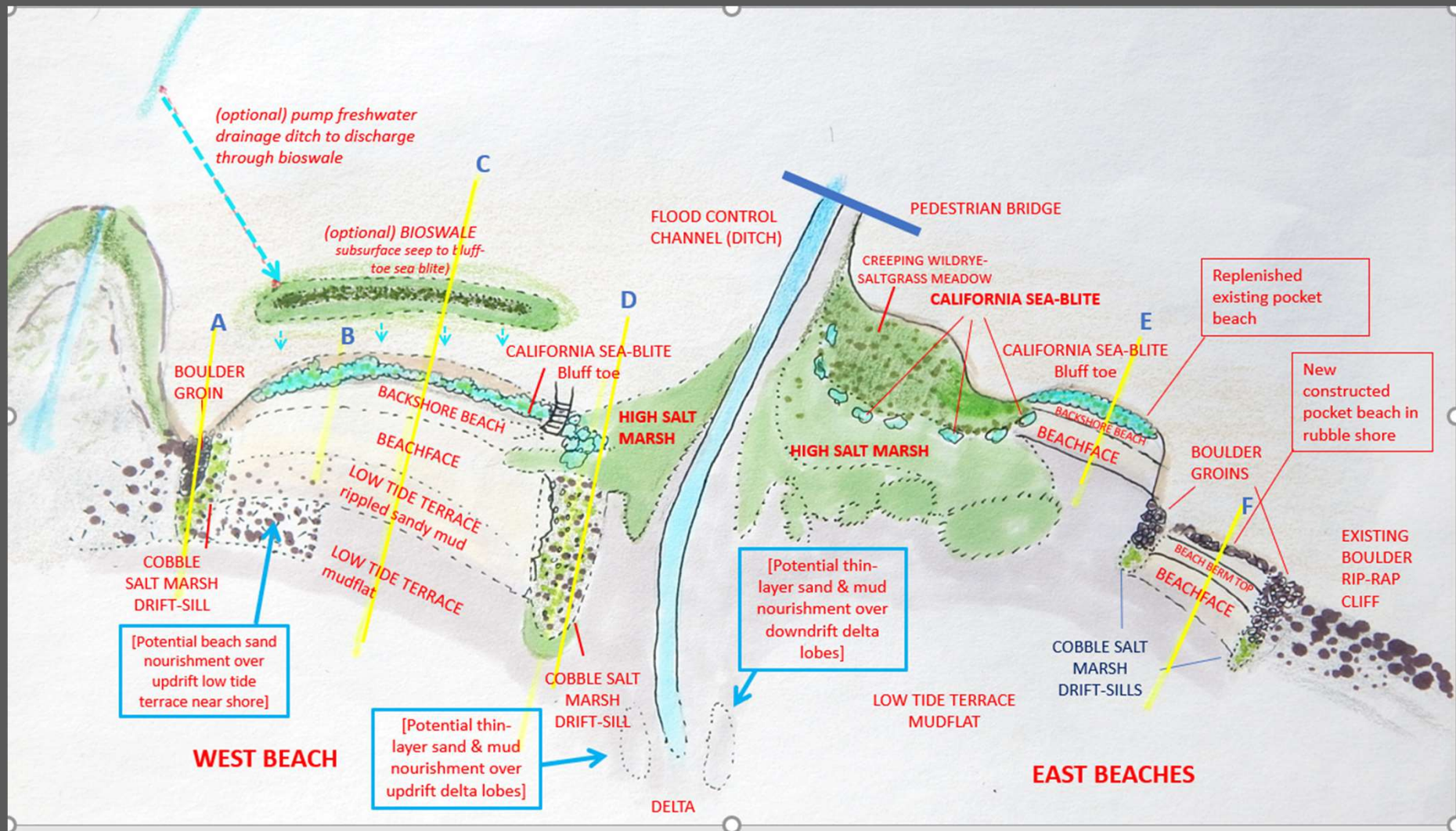
# Approach 2 - Dynamic Nourishment Approach

EAST BEACH E

EAST BEACH F









Aramburu Island, Marin

Constructed Bay Beaches as Soft Engineering Alternatives to Shoreline Armoring  
at Three Southern Marin County Demonstration Sites: Greenwood and Brunini  
Beaches, Tiburon; Paradise Beach, Tiburon; and Seminary Drive, Marin County

Preliminary Design Report

April 25, 2021

Prepared by:

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Two short videos...courtesy of Mark Lorang, PhD





